# DRUG NAME: Lomustine

**SYNONYM(S):** CCNU[1]

**COMMON TRADE NAME(S):** CeeNU®

**CLASSIFICATION:** alkylating agent

*Special pediatric considerations are noted when applicable, otherwise adult provisions apply.*

## MECHANISM OF ACTION:

Lomustine is a highly lipid-soluble nitrosourea compound.[2] Unlike carmustine, it is administered orally. Lomustine, a monofunctional alkylating agent, alkylates DNA and RNA, can cross-link DNA, and inhibits several enzymes by carbamoylation.[3];[4] It is cell cycle phase-nonspecific. Cross-resistance between carmustine and lomustine has occurred.[1]

## PHARMACOKINETICS:

| | | |
|---|---|---|
| Oral Absorption | rapidly absorbed[1] | |
| Distribution | widely distributed[1] | |
| | cross blood brain barrier? | passes readily; ≥50% of concurrent plasma concentrations |
| | volume of distribution | no information found |
| | plasma protein binding | 50%[5] |
| Metabolism | hepatic[6] | |
| | active metabolite(s) | yes[1] |
| | inactive metabolite(s) | yes[1] |
| Excretion | renal[5]; respiratory <10% as $CO_2$ | |
| | urine | metabolites |
| | feces | <5%[5] |
| | terminal half life | 16-72 h[5]<br>active metabolite[5]: 31.2-48 h |
| | clearance | no information found |

Adapted from standard reference[7] unless specified otherwise.

## USES:

***Primary uses:***

*Brain tumours
*Breast cancer
*Lung cancer
*Lymphoma, Hodgkin's
*Melanoma

*Health Canada approved indication

***Other uses:***

Colon cancer[5]

## SPECIAL PRECAUTIONS:

***Caution:*** Dose-related pulmonary toxicity may occur; patients receiving cumulative doses >1,100 mg/m$^2$ are at higher risk.[7] For more information, see paragraph following **Side Effects** table.

***Carcinogenicity:*** Lomustine is carcinogenic in rats and mice, producing significant increase in tumour production at doses approximating human doses.[7]

***Mutagenicity:*** Not reported to be Mutagenic in Ames test and mammalian *in vitro* mutation test.[8] Lomustine is clastogenic in mammalian *in vitro* and *in vivo* chromosome tests.[9]

***Fertility:*** Lomustine affects fertility in male rats at doses somewhat higher than human doses.[7] Prolonged azoospermia in humans likely.[10]

***Pregnancy:*** FDA Pregnancy Category D.[5] There is positive evidence of human fetal risk, but the benefits from use in pregnant women may be acceptable despite the risk (e.g., if the drug is needed in a life-threatening situation or for a serious disease for which safer drugs cannot be used or are ineffective). No congenital anomalies were observed in three children of women who had been treated in childhood or adolescence with lomustine for cancer.[11]

***Breastfeeding*** is not recommended due to the potential secretion into breast milk.[1]

## SIDE EFFECTS:

The table includes adverse events that presented during drug treatment but may not necessarily have a causal relationship with the drug. Because clinical trials are conducted under very specific conditions, the adverse event rates observed may not reflect the rates observed in clinical practice. Adverse events are generally included if they were reported in more than 1% of patients in the product monograph or pivotal trials, and/or determined to be clinically important.[12] When placebo-controlled trials are available, adverse events are included if the incidence is ≥5% higher in the treatment group.

| ORGAN SITE | SIDE EFFECT |
|---|---|
| Clinically important side effects are in ***bold, italics*** | |
| blood/bone marrow/ febrile neutropenia | anemia (1-10%)[5] |
| | ***leukopenia*** (>10%)[5]: onset 14 days, nadir 28-35 days, recovery 42 days; cumulative, dose-related, delayed; see paragraph following **Side Effects** table |
| | ***thrombocytopenia*** (> 10%)[5]: onset 14 days, nadir 28-35 days, recovery 42 days; cumulative, dose-related, delayed; see paragraph following **Side Effects** table |
| constitutional symptoms | lethargy |
| dermatology/skin | alopecia (1-10%)[1];[5] |
| | rash (1-10%)[5] |
| gastrointestinal | *emetogenic potential: low-moderate*[13] |
| | ***anorexia***; begins 2-3 days after oral dose, and may last for several days[1] |
| | diarrhea (1-10%)[5] |
| | ***nausea and vomiting*** (45-100%)[1]; typically begins within 45 min-6 h after oral dose and lasts for less than 24 h; frequency and duration can be reduced by the administration of lomustine to fasting patients |
| | stomatitis (1-10%)[5] |
| hepatobiliary/pancreas | hepatotoxicity (<1%)[5] |
| metabolic/laboratory | alkaline phosphatase; reversible increase[6] |

| ORGAN SITE | SIDE EFFECT |
|---|---|
| Clinically important side effects are in ***bold, italics*** | |
| | bilirubin; reversible increase[6] |
| | transaminase; reversible increase[6] (1-10%)[12] |
| neurology | ataxia |
| | disorientation |
| | dysarthria |
| ocular/visual | visual disturbances[1] (<1%) |
| pulmonary | ***pulmonary toxicity*** (<1%); see paragraph following **Side Effects** table |
| renal/genitourinary | renal toxicity (1-10%)[5]; decreased kidney size,[7] progressive azotemia and renal failure; dose-related |
| secondary malignancy | acute leukemia after long-term use |
| | bone marrow dysplasias after long-term use |
| sexual/reproductive function | prolonged azoospermia likely,[10] conclusive data not available |

Adapted from standard reference[7] unless specified otherwise.

***Myelosuppression:*** The most frequent and serious toxicity of lomustine is delayed myelosuppression.[7] It is cumulative and usually occurs 28-42 days after drug administration and is dose-related. Thrombocytopenia is usually more severe than leukopenia, but both may be dose-limiting. Anemia also occurs, but is less frequent and less severe. Due to the delayed and cumulative myelosuppressive effects, lomustine is usually given at intervals of at least 6 weeks. However, repeat courses of lomustine should not be administered until leukocyte and platelet counts have returned to acceptable levels.

***Pulmonary toxicity***: Pulmonary fibrosis and pulmonary infiltrates can occur rarely with lomustine use.[9] Pulmonary toxicity is more common with cumulative doses exceeding 1100 mg/m$^2$; however, it has occurred with lower doses. Early onset pulmonary toxicity can occur as early as 6 months from the start of therapy; however, late onset pulmonary fibrosis has been reported up to 15 years after treatment. Patients with baseline Forced Vital Capacity (FVC) or Carbon Monoxide Diffusing Capacity ($DL_{CO}$) below 70% of predicted levels are particularly at risk. Pulmonary function tests should be performed at baseline and throughout treatment. Patients should be advised to immediately report any signs of respiratory complications, and therapy should be discontinued.

**INTERACTIONS:** No documented drug interactions.

Lomustine is a major CYP2D6 substrate.[5] Lomustine is a weak CYP2D6 and CYP3A4 inhibitor.[5]

## SUPPLY AND STORAGE:

***Oral:*** Bristol Laboratories of Canada supplies lomustine as a 10 mg, 40 mg and 100 mg capsule.[714] Protect from light. Avoid excessive heat (over 40 ºC).

## DOSAGE GUIDELINES:

Refer to protocol by which patient is being treated. Numerous dosing schedules exist and depend on disease, response and concomitant therapy. Guidelines for dosing also include consideration of absolute neutrophil count

(ANC). Dosage may be reduced, delayed or discontinued in patients with bone marrow depression due to cytotoxic/radiation therapy or with other toxicities.

***Adults*:**

BC Cancer usual dose noted in ***bold, italics***

*Oral:*

Cycle Length:

4-6 weeks[14]: ***110 mg/m$^2$ PO for one dose on day 1***
(total dose per cycle 110 mg/m$^2$)
- round dose to the nearest 10 mg
- administering on an empty stomach[1,7] (one hour before or two hours after eating)[5] may help reduce nausea

6 weeks[151617]: ***75-130 mg/m$^2$ PO for one dose on day 1***
(total dose per cycle 75-130 mg/m$^2$)
- round dose to the nearest 10 mg
- administering on an empty stomach[17] (one hour before or two hours after eating)[5] may help reduce nausea

6-8 weeks[18]: ***130 mg/m$^2$ (range 80-160 mg/m$^2$) PO for one dose on day 1***
(total dose per cycle 130 mg/m$^2$ [range 80-160 mg/m$^2$])
- round dose to the nearest 10 mg
- administering on an empty stomach[17] (one hour before or two hours after eating)[5] may help reduce nausea

*Concurrent radiation:* currently not used in neuro-oncology[12]

*Dosage in myelosuppression:* modify according to protocol by which patient is being treated; suggested dose modification[16]:

| **ANC x 10$^9$/L** | | **Platelets x 10$^9$/L** | **Dose** |
|---|---|---|---|
| >1.5 | or | >100 | give 100% |
| 1.0-1.5 | and/or | 80-100 | give 80% |
| <1.0 | and/or | <80 | delay 1 week and resume at 60% of the original dose<br>• Note: this will be the new 100% dose thereafter. |

*Dosage in renal failure:*

Suggested dose modification[5]:

| **Creatinine clearance (mL/min)** | **Dose** |
|---|---|
| 10-50 | 75% |
| <10 | 50% |

*Dosage in hepatic failure:* hold lomustine if AST/GGT >5 x ULN or bilirubin >25 µmol/L until liver function returns to normal[1617]

*Dosage in dialysis:* hemodialysis[5]: supplemental dose for dialysis is not required

***Children:***

| | Cycle Length: | |
|---|---|---|
| *Oral*[4]*:* | 4-6 weeks: | 100-150 mg/m$^2$ for one dose on day 1<br>(total dose per cycle 100-150 mg/m$^2$)<br>• round dose to the nearest 10 mg<br>• administering on an empty stomach[17] (one hour before or two hours after eating)[5] may help reduce nausea |

## REFERENCES:


1. McEvoy GK. AHFS 2006 Drug Information. Bethesda, Maryland: American Society of Health-System Pharmacists, Inc.; 2006. p. 1125-1126.
2. Pizzo PA, Poplack DG. Principles and Practice of Pediatric Oncology. 5th ed. Philadelphia: Lippincott - Raven; 2006. p. 310-313.
3. USP DI® Drug Information for the Health Care Professional (database on the Internet). Lomustine. Thompson MICROMEDEX®, Available at: www.micromedex.com. Accessed 17 February 2007.
4. Pizzo PA, Poplack DG. Principles and Practice of Pediatric Oncology. 5th ed. Philadelphia: Lippincott - Raven; 2006. p. 300.
5. Rose BD editor. Lomustine: Drug Information. www.uptodate.com ed. Waltham, Massachusetts: UpToDate 14.3; 2007.
6. DRUGDEX® Evaluations (database on the Internet). Lomustine. Thomson MICROMEDEX®, Available at: www.micromedex.com. Accessed 17 February 2007.
7. Bristol Laboratories of Canada. CeeNU® (lomustine) Product Monograph. Montreal, Quebec; May 2000.
8. Chabner BA, Longo DL. Cancer Chemotherapy and Biotherapy. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2001. p. 71.
9. REPROTOX® [database on the Internet]. Lomustine. Thompson MICROMEDEX®, Available at: http://www.micromedex.com/;, 17 February 2007.
10. DeVita VT, Hellman S, Rosenberg SA. Cancer Principles & Practice of Oncology. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2001. p. 2925-2926.
11. TERIS [database on the Internet]. Lomustine. Thompson MICROMEDEX®, Available at: http://www.micromedex.com/;, 17 February 2007.
12. Brian Thiessen MD. Personal communication. Neuro-oncologist, BC Cancer Agency; 26 February 2007.
13. BC Cancer Agency. (SCNAUSEA) Guidelines for Prevention and Treatment of Chemotherapy-induced Nausea and Vomiting in Adults. Vancouver, British Columbia: BC Cancer Agency; 1 November 2005.
14. BC Cancer Agency Neuro-oncology Tumour Group. (CNMODPCV) BCCA Protocol Summary for Modified PCV Chemotherapy of Brain Tumours Using Procarbazine, Lomustine (CCNU) and Vincristine. Vancouver, British Columbia: BC Cancer Agency; 1 August 2006.
15. BC Cancer Agency Melanoma Tumour Group. (SMCCNU) BCCA Protocol Summary for Palliative Therapy for Metastatic Melanoma Using Lomustine (CCNU). Vancouver, British Columbia: BC Cancer Agency; 1 June 2003.
16. BC Cancer Agency Neuro-oncology Tumour Group. (CNCCNU) BCCA Protocol Summary for Lomustine (CCNU) for Treatment of Recurrent Malignant Brain Tumours. Vancouver, British Columbia: BC Cancer Agency; 1 August 2006.
17. BC Cancer Agency Neuro-oncology Tumour Group. (CNCCV) BCCA Protocol Summary for Adjuvant Lomustine, Cisplatin and Vincristine in Adult High-Risk Medulloblastoma or other Primitive Neuro-Ectodermal Tumour (PNET). Vancouver, British Columbia: BC Cancer Agency; 1 August 2006.
18. BC Cancer Agency Lymphoma Tumour Group. (LYPALL) BCCA Protocol Summary for Lymphoma Palliative Chemotherapy. Vancouver, British Columbia: BC Cancer Agency; 1 September 2006.